

Electronic Parts Evaluation Activities

at



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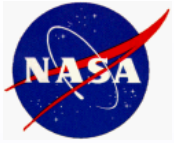
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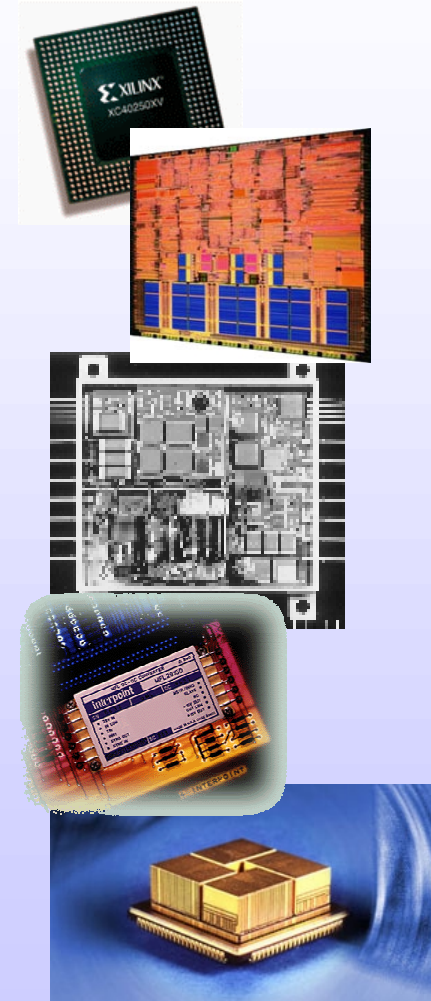
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Overview



- ***Evaluate and assess new and advanced microelectronics device technologies for application in high reliability systems***
 - *Identify common failure modes and mechanisms of new technologies*
 - *Evaluation and characterization of new device Technologies*
 - *Provide an infusion path for advanced technologies*
 - *Develop innovative and cost effective reliability and qualification methods*
- ***Develop a new strategic alliances with industry, academia, and other government agencies for evaluation activities***

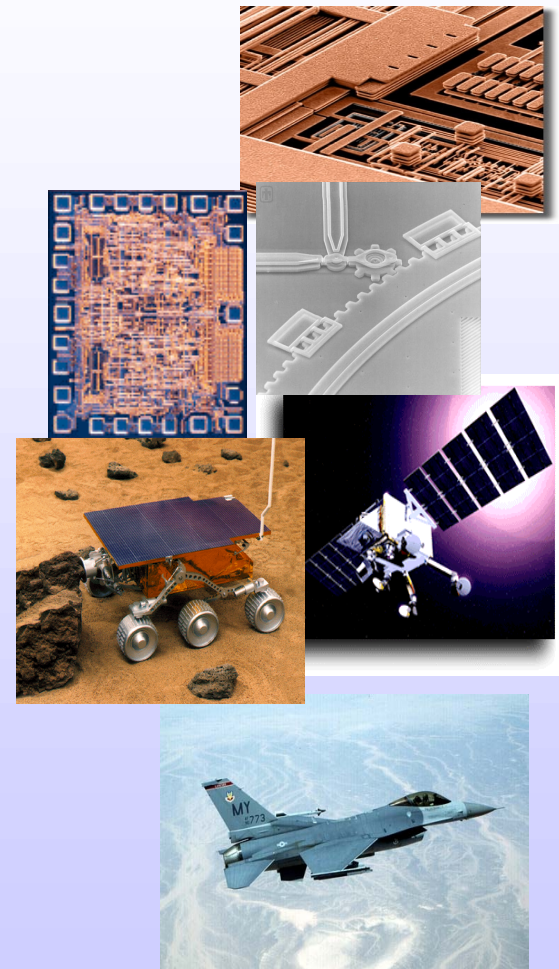




Parts Challenges



- **Technical challenges**
 - *Smaller feature sizes and miniaturization*
 - *Low power devices and processes*
 - *Device complexity*
 - *Radiation Tolerance of commercial Processes*
- **Environmental challenges**
 - *Operation at extreme temperatures*
 - *Reduction in mass and volume*
 - *New radiation effects and high radiation environments*
- **Programmatic challenges**
 - *Fast, better, cheaper missions*
 - *1/2 the cycle time, 2/3 the cost*
- **Industry challenges**
 - * *Diminishing Hi-Rel suppliers*
 - *No supporting military infrastructure and standards*
 - *No procurements for small volume*

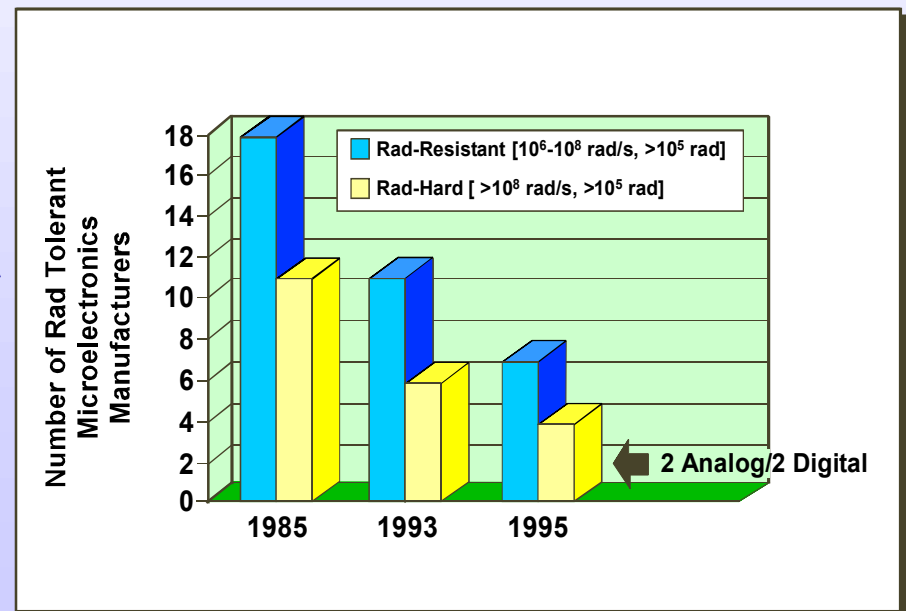




Diminishing Hi-Rel Suppliers



- *Military/space market represents too small a customer to drive new technology development*
- *Diminishing Hi-Rel suppliers means*
 - *No high-performance and high-reliability parts*
 - *No standard on screening/qualification*
 - *No rad-hard parts/processes*
- *Focus on assessing new technologies and electronic parts to understand the following for Hi-Rel applications*
 - *More electrical characterizations*
 - *Upscreening and qualification tests*
 - *Identification of dominant failure modes for various requirements*
 - *Radiation characterization tests*
 - *Material characteristics*
 - *Reliability of advanced technology devices for extreme environments*
 - *Reliability and quality assurance standards for highly reliable parts*

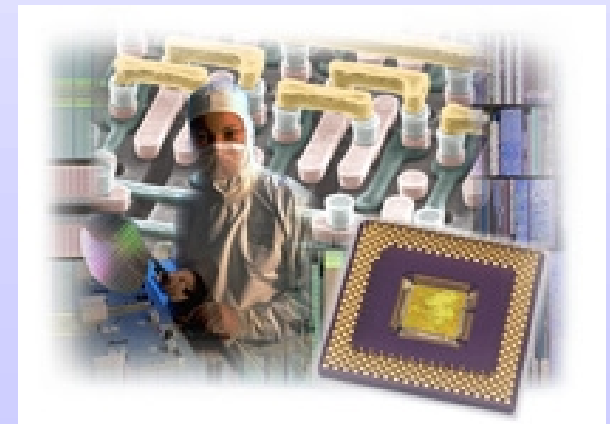
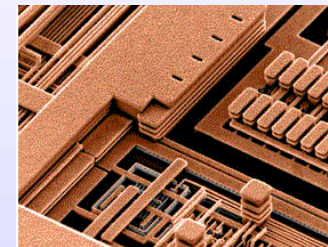
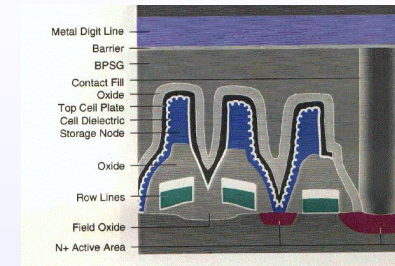




COTS Evaluations



- ***The miniaturization and commercialization trends are the driving force for usage of COTS for space flight projects***
- ***The challenge is to use COTS in high radiation and reliability requirements***
 - ***Identify the reliability and validate COTS for flight projects***
 - ***Evaluation of SDRAMs, EEPROMs, Flash Memories for high temperature and high radiation environments***
 - ***Evaluation of various discretes, passives, linear devices***
 - ***Provide upscreening options for projects with a variety of risk levels for using COTS devices***
 - ***Provide KGD requirements for insuring reliability of COTS devices for flight projects***





COTS Evaluations (cont.)



■ PEMS

- *Establish validation methods for plastic (PEM) parts*
- *Develop tailored upscreen procedure for insuring reliable PEMs in JPL Flight projects*
- *Develop a baseline approach for reliability assurance for space flight applications*
- *Enable flight projects to use state-of-the-art devices not otherwise available*

- *Need to develop of new strategic alliances with industry, academia, and other government agencies to leverage resources for COTS reliability/qualification evaluations*



<http://cots.jpl.nasa.gov/>



DC/DC Converters



■ Objective

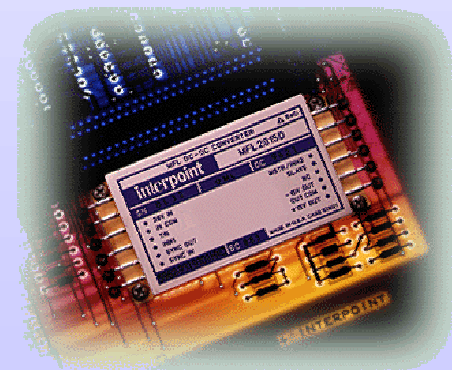
- *Identify and publish a list of preferred DC/DC converter suppliers and technologies for space application*
- *Evaluate reliability of DC/DC converters and publish reliability assurance guidelines*

■ Status

- *Completed evaluation reports from on-site supplier line evaluations, DPA, and other environmental testing*
- *Produced summary matrix for DC/DC converter selection criteria*

■ Plan

- *Generate listing of preferred/qualified suppliers*





Electronic Parts Evaluation Activities at JPL

Reliability of Cu-Based Microelectronic Metallization Systems

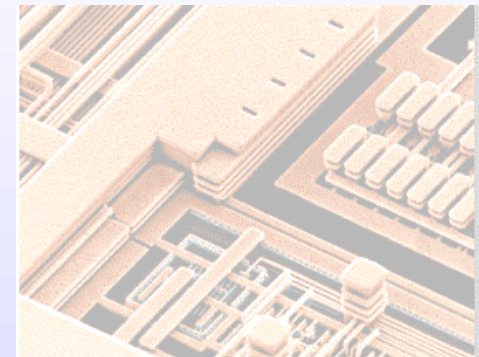


■ Objective

- *Evaluate reliability of Cu-based microelectronic metalization systems*

■ Status

- *Engineering studies of Cu/low-k systems*
 - *Expected failure mechanisms identified*
 - *Variability due to process seen as major issue*
 - *Critical reliability detractors found*
 - *Experiments identified*
- *Presented several papers in various conferences*



■ Plan

- *Publish a report on expected failure modes and mechanisms for Cu/low-k interconnect systems*
- *Provide recommendations for use and application of these materials in high reliability space flight systems*



SOI Reliability



■ Objective

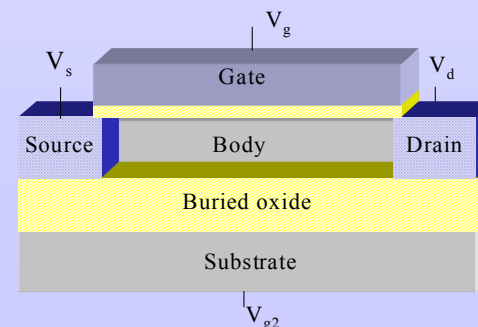
- *Perform a comprehensive technology characterization of SOI Mixed Signal ASIC processes in partnership with industry, academia, and government-sponsored laboratories*
- *Provide critical information for design engineers and circuit designers relating to the characteristics and limitations of this new technology for high reliability applications (in an extended temperature range down to -150°C)*

■ Status

- *Completed low temperature evaluation of DC characteristics (300K to 77K) for 0.25-um FD-SOI transistors.*
- *Obtained preliminary proton radiation test results.*

■ Plan

- *Evaluate 0.18-um fully-depleted and 0.8-um partially-depleted devices for mixed-signal applications.*
- *Modify device parameters using simulation tools and, based on simulation results, fabricate devices with better performance in harsh environments.*





Non-Volatile Memory (NVM) Evaluation



■ Objective

- *Develop a test methodology for determination of non-volatile memory (NVM) reliability and radiation effects and construction of a test structure for characterization.*

■ Status

- *Characterization of all major NVM types:*
 - *Floating gate technology: including PROM, UVPRO, EEPROM, PLED, and flash technologies*
 - *Ferroelectric technology: including GMRAM, FeRAM, Spin Valve, and PZT technologies*
 - *Phase Change Materials Technology: including Chalcogenide and Antifuse technologies*

■ Plan

- *Develop test structures and methodology for testing of NVM:*
 - *Reliability and operational liability of NVM*
 - *Radiation effects and mitigation strategies*
 - *Develop NVM characterization test database from existing data and test matrix required for complete characterization*



KGD for Space Applications



■ Objective

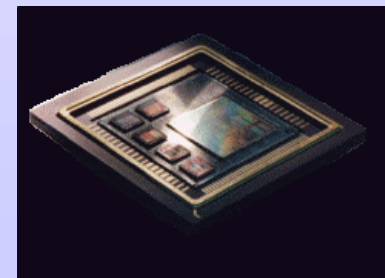
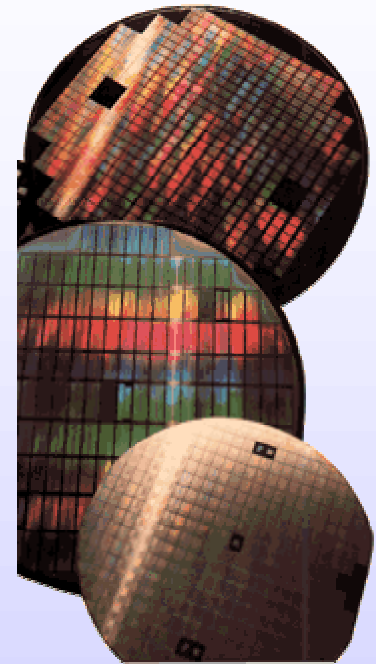
- *Establish all requirements for semiconductor KGD which are purchased by JPL or its subcontractors for use in JPL flight projects*

■ Status

- *Developed guidelines for insuring two level KGD in JPL flight hardware and an operating procedure for die storage and handling*
- *Collected and reviewed KGD test methods, KGD vendor programs, KGD test options, and risk associated with KGD screens/options*

■ Plan

- *Facilitate future die procurements, infusion, and usage*





Electronics For Extreme Environments



■ Objective

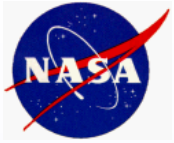
- *Develop reliability assessments of electronic parts at extreme environments and identify failure mechanisms to support future JPL/NASA flight projects*

■ Status

- *Conducted characterization tests on a number of parts in support of JPL flight projects at low temperature (-170 C)*
- *Report “Failure Mechanisms In Electronic Devices At Low Temperatures Part I: Electrically Induced Failures”*
- *Report on Failure Mechanisms In Electronic Devices At Low Temperatures, Part II: Mechanically Induced Failures: “Thermo-Mechanical Stress Induced Failures in Die Metallization Lines – an Overview”*
- *Report “Die Attachment For -120 C To +20 C Thermal Cycling Of Microelectronics For Future Mars Rovers - An Overview”*

■ Plan

- *Support the Mars Program in test and characterization of commercial encoder boards for low temperature applications*



Other Parts Evaluation Activities



- *Radiation Effects*
- *MEMS Reliability*
- *Compound Semiconductor Reliability*
- *SiGe Reliability*
- *Optoelectronic And Photonic Devices*
- *InP Reliability Characterization*
- *TEM as a Reliability Tool*
- *Specific parts Evaluations*



Summary



- *COTS insertion into high reliability space systems requires detailed knowledge of the performance and characteristics of these components in a space environment*
- *A systematic approach to the “qualification” of COTS components is a must*
- *Understanding the technology and the intended application are essential first steps of qualification*
- *There is a clear need to leverage resources and develop strategic alliances for the evaluation and characterization of COTS components for high reliability applications.*



Acknowledgement



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